

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 05088177
PUBLICATION DATE : 09-04-93

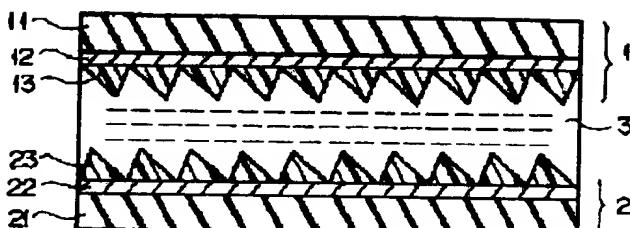
APPLICATION DATE : 30-09-91
APPLICATION NUMBER : 03251822

APPLICANT : TOSHIBA CORP;

INVENTOR : KAWADA YASUSHI;

INT.CL. : G02F 1/1337

TITLE : LIQUID CRYSTAL DISPLAY ELEMENT



ABSTRACT : PURPOSE: To decrease the contamination of substrates, the electrostatic breakdown of the respective elements, etc., formed on the substrates, the defects of liquid crystal images, etc., and to uniformize the orientation to liquid crystal molecules.

CONSTITUTION: A pair of the substrate parts 1, 2 having substrates 11, 21 and oriented films 13, 23 coating these substrates are disposed apart a specified distance by disposing the oriented film 13, 23 side on the opposite surfaces. A liquid crystal 3 is sealed between these two substrate parts. Periodic or non- periodic rugged patterns which are respectively asymmetrical in the sectional shape of the ruggedness are formed by a chemical treatment on the surfaces of the substrates 11, 21 and/or the opposite surfaces of the oriented films 13, 23 respectively in the substrate parts 1, 2. The opposite surfaces of the respective substrate parts in contact with the liquid crystal have the periodic or non-periodic rugged patterns which are respectively asymmetrical in the sectional shape of the ruggedness along the rugged patterns on the surfaces of the substrates 11, 21 and/or the opposite surfaces of the oriented films 13, 23.

COPYRIGHT: (C)1993,JPO&Japio

LIQUID CRYSTAL DISPLAY ELEMENT

Patent Number: JP5088177

Publication date: 1993-04-09

Inventor(s): KAWADA YASUSHI

Applicant(s): TOSHIBA CORP

Requested Patent: JP5088177

Application Number: JP19910251822 19910930

Priority Number(s):

IPC Classification: G02F1/1337

EC Classification:

Equivalents:

Abstract

PURPOSE: To decrease the contamination of substrates, the electrostatic breakdown of the respective elements, etc., formed on the substrates, the defects of liquid crystal images, etc., and to uniformize the orientation to liquid crystal molecules.

CONSTITUTION: A pair of the substrate parts 1, 2 having substrates 11, 21 and oriented films 13, 23 coating these substrates are disposed apart a specified distance by disposing the oriented film 13, 23 side on the opposite surfaces. A liquid crystal 3 is sealed between these two substrate parts. Periodic or non- periodic rugged patterns which are respectively asymmetrical in the sectional shape of the ruggedness are formed by a chemical treatment on the surfaces of the substrates 11, 21 and/or the opposite surfaces of the oriented films 13, 23 respectively in the substrate parts 1, 2. The opposite surfaces of the respective substrate parts in contact with the liquid crystal have the periodic or non- periodic rugged patterns which are respectively asymmetrical in the sectional shape of the ruggedness along the rugged patterns on the surfaces of the substrates 11, 21 and/or the opposite surfaces of the oriented films 13, 23.

Data supplied from the **esp@cenet** database - 12

(19) 日本国特許庁 (JP)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平5-88177

(43) 公開日 平成5年(1993)4月9日

(51) Int.Cl.⁵

G 0 2 F 1/1337

識別記号

庁内整理番号

7348-2K

F I

技術表示箇所

審査請求 未請求 請求項の数1(全8頁)

(21) 出願番号 特願平3-251822

(22) 出願日 平成3年(1991)9月30日

(71) 出願人 000003078

株式会社東芝

神奈川県川崎市幸区堀川町72番地

(72) 発明者 川田 靖

神奈川県川崎市幸区小向東芝町1番地 株式会社東芝総合研究所内

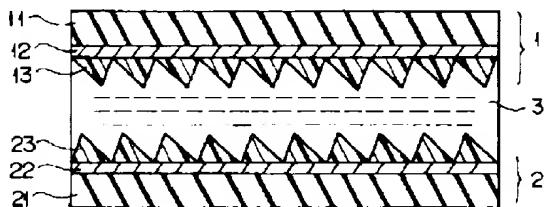
(74) 代理人 弁理士 鈴江 武彦

(54) 【発明の名称】 液晶表示素子

(57) 【要約】

【目的】 液晶表示素子において、基板の汚染、基板上に形成された各素子等の静電破壊、液晶画像の欠陥等を低減させ、且つ液晶分子に対する配向均一性を達成することを目的とする。

【構成】 基板11、21これらを被覆した配向膜13、23とを有する一対の基板部1、2が、配向膜13、23側を対向表面として一定距離を隔て配置されている。両基板部間には液晶3が封入されている。基板部1、2の夫々において、基板11、21の表面および/または配向膜13、23の対向表面には化学的処理によって各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが形成されている。各基板部の液晶と接する対向表面は、前記基板11、21の表面および/または配向膜13、23の対向表面の凹凸パターンに沿った各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンを有する。



【特許請求の範囲】

【請求項1】 基板と該基板表面を被覆する高分子材料により形成された配向膜とを有し、前記配向膜側を対向表面として一定距離を隔て配置された一対の基板部と、該一対の基板部間に封入された液晶とを具備した液晶表示素子であって、

前記基板部の夫々において、前記基板表面および／または配向膜の対向表面には化学的処理によって各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが形成されていること、

前記各基板部の液晶と接する対向表面が、前記基板表面および／または配向膜の対向表面の凹凸パターンに沿つた、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンを有することとを特徴とする液晶表示素子。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、液晶表示素子に関する。

【0002】

【従来の技術】 一般的に、液晶表示素子は、一定距離を隔て対向して配置された一対の基板と、これら夫々の基板の互いに対向する表面を被覆する配向膜と、前記基板間にこれら配向膜を介して封入された液晶とにより構成されている。このような液晶表示素子では、画素部において前記基板上に透明電極が積層され、更に該透明電極上に配向膜が形成されており、透明電極によって液晶に対して電圧の印加がなされる。特に、近年では、アクティブラチックス型の表示方式に使用される液晶表示素子として、前記画素部における一方の基板上に薄膜トランジスタ (TFT, Thin Film Transistor) 等の駆動素子が実装された液晶表示素子が開発され実用化されている。

【0003】 上述したような液晶表示素子の構成部材のうち、前記配向膜はその液晶と接する表面において液晶分子を一定方向に配向させる目的で、絶縁性の膜表面に各種の配向処理がなされたものである。これら配向処理として、従来よりラビング法と呼ばれる処理が広く行われている。

【0004】 このラビング法とは、基板上に形成された絶縁性の高分子膜等における液晶と接する表面を、綿、布等の繊維状物質を用いて一定方向に擦る（ラビングする）ことによって、膜表面に液晶に対する配向能を付与する方法である。該配向能については、ラビングにより高分子膜表面に形成される微小な凹凸により液晶分子のチルトアングル（液晶分子が基板に対し傾斜して配向する角度）が制御されるという説（形状効果説）、また該膜表面がラビングされる際に延伸されこれによって膜を形成する高分子が配向し、この配向に従って液晶分子の配向の方向性、均一性が制御されるという説（インタラ

クション効果説）が提唱されている。また、ラビング処理の方向によって、液晶表示画像の最終的な視覚方向が決定されると考えられている。このラビング法による配向処理は、簡易で且つ非常に単純な製造装置を使用することができ、短時間で大量の配向膜の形成が可能で、且つ処理された配向膜の液晶分子に対する配向規制力が極めて強いという点で、現在の液晶表示素子の製造に最も頻繁に使用されている。

【0005】 しかしながら、上記ラビング法では、表示面積が小さな（配向膜の面積が小さい）液晶表示素子においては均一なラビング処理が可能である反面、表示面積が大きな（配向膜の面積が大きい）素子においては、基板上の膜表面に対する繊維状物質の接触圧力を均一に設定することが困難になる。この接触圧力は制御が容易ではなく、更に使用される繊維状物質の耐久性に起因して、部分的、経時に変化する。以上のことから、形成される配向膜の性能が膜全体で不均一になり、量産においても再現性が示され難く、液晶表示素子の表示画像内における液晶物質の配向均一性が不充分になる。

【0006】 また、ラビング法では、使用される繊維状物質の構成成分（糸屑等）により基板およびその周辺部の汚染が引き起こされる。更に、高分子膜のような誘電体上を布により摩擦する工程が含まれ、配向膜上に大量の静電気が発生する。このため基板表面が帯電し、ゴミが吸着して基板間のギャップが所定の間隔より広がり、形成された液晶表示素子において不良が発生する。また、基板上の薄膜表面を布により摩擦する工程では基板表面に不要な傷が発生し、これによっても液晶表示画像の欠損も生ずる。

【0007】 以上のような、ラビング法による配向処理の欠点は、特に前記アクティブラチックス型表示方式に使用される液晶表示素子においては更に大きな問題となる。このような液晶表示素子では、ラビングの際に発生する静電気によって基板上に設けられている駆動素子が破壊されるため、これによって当該液晶表示素子の不良率が更に上昇する。また、当該液晶表示素子において、画素部における駆動素子が実装された基板表面を被覆する薄膜（配向膜）の表面には、該駆動素子の存在によって凹凸が存在し平坦化が損われているために、薄膜全表面に亘って均一にラビングを施すことができない。この結果、ラビングの際に処理のムラが生じ、形成された配向膜の液晶に対する配向能の分布が不均一となり、液晶表示の画像欠損が発生する。また、ラビング処理方向に対する規制が生じ易く、これによって液晶表示画像の視覚方向も規制され、形成される液晶表示素子の応用範囲が狭くなり、その実用価値が低下する。

【0008】 以上のように、現行のラビング法では液晶表示素子の品質にとって問題点が多数存在する。従つて、前記ラビング法に代わる配向処理方法（配向膜形成方法）が強く要望されており、この要望に応えるために

幾つかの研究が報告されている。

【0009】現在研究されている配向膜形成方法は、以下の事実に基づいている。即ち、等間隔に並んだ直線状の凹凸溝を有する基板（配向膜）上に液晶分子を置いた場合、その溝に沿った方向にこれら液晶分子が配向するという事実である。この事実については、H.V.ケネルらによるPhysical Review A24(5)2713(1981)、A. SugiyamaらによるJpn. J. Appl. Phys. 20(7)1343(1981)等に記載されている。例えば、横山和夫らによる特開昭60-60624号では、レーザー光の2光束干渉縞を基板表面に照射することにより、グレーティング状の凹凸を形成する方法が開示されている。また、田中らによる特開昭61-11725号では、ネガ型感光性PVA膜にマスクパターンを転写および露光することにより、配向膜を形成する方法が開示されている。しかし、これらの方法は、いまだ工業的な実施レベルに至っていない。例えば、上記特開昭61-11725号の配向膜は、液晶表示素子に使用するための充分な耐熱性を有していない。

【0010】また、上述したような配向膜を有する液晶表示素子では、液晶分子の配向均一性が充分に達成されない。これは、前記配向膜の各凹凸の断面形状が矩形等の対称な形状であることに起因していると推定されている。即ち、各凹凸の断面形状が対称形である場合、特に凹凸を構成するグループ方向に対する、液晶分子の配向角度を任意に制御することが困難であることに起因していると考えられている。

【0011】

【発明が解決しようとする課題】本発明は上記問題点に鑑みてなされたもので、その課題とするところは、基板の汚染、基板上に形成された各素子等の静電破壊等が低減され、液晶画像の欠陥が非常に少なく、且つ液晶分子に対する配向均一性が達成され得る高性能の液晶表示素子を提供することである。

【0012】

【課題を解決するための手段】本発明の液晶表示素子は、基板と該基板表面を被覆する高分子材料により形成された配向膜とを有し、前記配向膜側を対向表面として一定距離を隔て配置された一対の基板部と、該一対の基板部間に封入された液晶とを具備し、前記基板部の大々において、前記基板表面および/または配向膜の対向表面には化学的処理によって各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが形成されていることと、前記各基板部の液晶と接する対向表面が、前記基板表面および/または配向膜の対向表面の凹凸パターンに沿った、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンを有することとを特徴とする。以下、本発明の詳細を説明する。

【0013】本発明の液晶表示素子において、前記基板部の液晶と接する対向表面の形状は、各凹凸の断面形状が非対称であるような凹凸形状であり、この凹凸形状が

液晶分子の配向を制御すると推定される。一般的に、基板部の液晶と接する対向表面は配向膜の液晶と接する表面に相当するため、直接的にはこの配向膜における液晶と接する表面の凹凸形状が液晶分子の配向を制御することになる。

【0014】本発明において、基板部の対向表面における各凹凸の断面形状が非対称であるとは、該凹凸における谷線（凹部）または尾根線（凸部）の方向に対して垂直方向に沿った断面で、凹凸が非対称な图形であることを意味する。

【0015】本発明の液晶表示素子では、上記各基板部の対向表面における凹凸パターンは、基板部を構成する基板または配向膜のうち少なくとも一層の形状に因るものであればよい。即ち、基板および配向膜のうち、少なくとも一層の表面が、化学的処理によって形成された各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンを有し、このような凹凸パターンが、最終的に前記基板部における液晶と接する対向表面に現れていればよい。

【0016】前記基板部を構成する基板は、通常ガラス等の素材で形成されており、更に表面に銅等の薄膜層を有してもよい。この表面をイオンビームエッティング等の化学的処理により掘削することにより、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが付与され得る。

【0017】一方、前記基板部を構成する配向膜には、感光性（光硬化性）ポリイミド等の感光性高分子によって形成された薄膜が使用され、この表面にフォトリソグラフィ等の化学的処理を施すことにより、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが付与され得る。また、上述したように基板表面が処理されて凹凸パターンを有する場合、該基板を被覆する配向膜として、光硬化性ポリイミド、熱硬化性ポリイミド、エポキシ樹脂等が使用され得る。これら樹脂を凹凸パターンを有する基板上に成膜し、更に硬化させて該基板上の凹凸パターンを転写する。

【0018】このように、本発明の液晶表示素子では、基板および配向膜の何れの場合も、従来のラビング法による処理を用いることなく、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンが形成されている。

【0019】次に、上述したような本発明の液晶表示素子の画素部における断面構造の具体例を、図1および図2を参照して説明する。尚、図1に示す液晶表示素子は、前記基板部における配向膜表面が、各凹凸の断面形状が非対称である周期的または非周期的な凹凸パターンを有し、この凹凸パターンが基板部における液晶と接する表面に現れたものである。

【0020】図1において、1および2は基板部である。基板部1は、基板11とITO(Indium Tin Oxide)

e) 膜等の透明導電膜12(透明電極)と配向膜13との積層体である。また、基板部2も同様の構造で、基板21と透明導電膜22と配向膜23との積層体である。該基板部1および2は、各配向膜13および23の側を対向表面とする形で一定の間隔をおいて対向しており、この対向表面には液晶3が封入されている。

【0021】基板部1および2において、配向膜13、23の夫々の表面には、図示の如く各凹凸の断面形状が非対称である周期的な凹凸パターンが形成されており、この凹凸パターンが基板部における液晶と接する表面に現れている。尚、当該凹凸パターンは、非周期的なものであってもよい。

【0022】図2は、図1における配向膜23の構造を詳細に示した斜視図である。同図に示す如く、配向膜23の各凹凸の断面形状は非対称な三角形状の图形であり、これら凹凸は直線状に配列されている。本発明の液晶表示素子では、この配向膜表面、または基板表面等に形成される断面形状が非対称の凹凸(基板部表面の凹凸)は、液晶分子の配向の方向を規制するため、凸部に複数の角部を有する多角形であることが好ましい。但し、この凸部における角部は実際の加工技術を考慮して1~2点となり、更に、各凹凸において同等の位置に存在する角部は、原則的に一直線状に存在する。特に、図2に示す配向膜23の如く、凸部における角部が1点、即ち凹凸の断面形状が非対称な三角形である場合が好ましく、その形状において下記式(1)~(4)が満たされる場合が特に好ましい。

$$a < b \quad \dots (1)$$

$$a + b = d \quad \dots (2)$$

$$d < 1.67 \times 10^{-6} \quad \dots (3)$$

$$h/d > \tan 13^\circ \quad \dots (4)$$

(式中、a、bは各凹凸の傾斜面の水平距離、dは凹凸の一周期、hは凹凸の高さを夫々示す。図2参照)

【0023】尚、基板部の対向表面における凹凸の断面形状が非対称な三角形状である液晶表示素子では、上記式(1)~(4)を満たさない場合、液晶分子の配向均一性即ち、配向秩序度の低下が生ずる恐れがある。しかしながら、本発明では、配向膜と液晶材料との相互作用を考慮することにより、前記式(1)~(4)を満たさない液晶表示素子でも、液晶分子の配向秩序度を向上させることができ充分に可能である。

【0024】本発明の液晶表示素子は、封入される液晶分子の種類、分子量に因らず、また、一般的な液晶表示方式、即ち、単純マトリックス方式、アクティブマトリックス方式の何れの方式においても適用することが可能である。

【0025】

【作用】本発明の液晶表示素子では、液晶分子の配向状態に対する制御が前記基板部の対向表面における凹凸パターンによってなされる。この凹凸パターンは、該基板

部を構成する基板または該基板を被覆する配向膜の化学的処理によって形成されたものである。即ち、本発明の液晶表示素子では、従来のラビング法を用いて液晶分子に対する配向能が付与されたものであり、基板等の汚染、および素子の電気的破壊といった問題点が回避され、基板部の液晶表示画像全面に亘ってムラなく均一に配向処理がなされ得る。

【0026】また、本発明の液晶表示素子では、前記基板部の対向表面における凹凸パターンにおいて、各凹凸の断面形状が非対称であることに起因して、特に、基板部の液晶と接する対向表面付近で、液晶分子の配向の方向を良好に制御することが可能になる。更に、この凹凸形状を制御することによって、例えば、図2に示す配向膜における凹凸の一周期($d = a + b$)、凸部の高さ(h)、非対称性($a : b$)、傾斜角(θ)等を制御することによって、液晶分子の配向方向、即ち、基板部表面の凹凸溝における谷線(凹部)または尾根線(凸部)に対する液晶分子長軸方向の角度、およびチルトアングル、即ち、基板部表面に対する液晶分子の傾斜角を、夫々自在に制御することが可能である。こうして、液晶表示素子における液晶分子の配向均一性が達成され得る。

【0027】

【実施例】以下、本発明の実施例を説明する。尚、これら実施例は、本発明の理解を容易にする目的で記載されるものであり、本発明を限定するものではない。

実施例1~5

【0028】透明基板の各表面上に、感光性ポリイミドを厚さ700~2000Å(オングストローム)に成膜し、配向膜層を形成した。次に、該配向膜層表面を、周期的なパターン形状のスリットを有する露光用マスクを介して、平行露光機(PLA-105、ニコン社製)を用いて露光した。このとき、露光用マスクにおける、ラインおよびスペースの間隔を1.67~0.9μmの範囲内で設定した。統いて、現像およびリソフ処理を行って不要なポリイミドを除去し、更に温度230°Cにてアーナーを施して基板上に周期的な断面矩形の凹凸パターンを形成した。このパターンにおける凹凸部の周期は、前記露光用マスクのラインおよびスペースの間隔によって決定される。

【0029】次いで、大型真空チャンバー内で、上記断面矩形の凹凸パターンを有する配向膜層に対しイオンビームエッチング処理を行い、矩形の凹凸の角部を欠落させ、各凹凸の断面形状が非対称な三角形である凹凸パターンを形成した。即ち、透明基板上に図2に示す如き断面三角形の凹凸パターンを有する配向膜を形成した。

【0030】以上のように得られた凹凸パターンを有する一対の基板部を用い、常法に従って液晶を封入し、基板部の表面において凹凸パターンの周期の異なる5種類の液晶表示素子(実施例1~5)を作製した。

【0031】これら実施例1~5の液晶表示素子の夫々において、液晶分子の配向方向、チルトアングル、およ

び配向秩序を測定し、これらと液晶表示素子の基板部表面における凹凸パターンの周期との関係（周期依存）について評価した。結果を下記表1に示す。尚、表1における各実施例の傾斜角とは、図2に示す形状の凹凸における角θに相当する。

【0032】また、液晶分子の配向方向と凹凸パターンの周期との関係については、図3の線図に示す。同図において、縦軸は液晶分子の配向方向、即ち、基板部表面の凹凸溝における谷線（凹部）または尾根線（凸部）に対する液晶分子長軸方向の角度を、横軸は凹凸パターンの周期を夫々示す。

実施例6～9

【0033】イオンビーム・エッティング処理の条件を除き、実施例1～5と同様の方法に従って、透明基板上に、図2に示す如き、各凹凸の断面形状が非対称な三角形である凹凸パターンを有する配向膜を形成し、更にこれを用いて液晶表示素子を作製した。詳しくは、イオンビーム・エッティング処理の際に、イオンビーム照射方向と基板法線との角度を、0°を超える有限の角度～76.4°の範囲内で変化させ、液晶と接する基板部の表面において凹凸の傾斜角の異なる4種類の液晶表示素子（実施例6～9）を作製した。

【0034】これら実施例6～9の液晶表示素子の夫々において、液晶分子の配向方向、チルトアングル、および配向秩序を測定し、これらと液晶表示素子の基板部表面における凹凸パターンの傾斜角との関係（傾斜角依存）について評価した。結果を下記表1に併記する。

実施例10～14

【0035】ガラス基板またはそれに相当する基板上にフォトレジスト薄膜を、厚さ1μmで形成した。次に、該フォトレジスト薄膜に対し、スリット状マスクを介して、またはレーザフォログラフィック技術を用いて露光を行った。ここで、スリット状マスクとしては実施例1～5で使用した露光用マスクと同様のマスクを使用した。また、レーザフォログラフィック技術とは、位相が制御されたレーザ光を投影することにより得られる干渉パターンを用いて、フォトレジスト薄膜に対する露光を行うものであり（エシェレット回折格子の製造技術、日本国特許第1046763号）、より微細なパターンを必要とする配向膜、または前記露光用マスクによる露光の施し難い材料に対して適用される。統いて、露光後のフォトレジスト薄膜に対して現像およびリソス処理を行い、基板上に周期的なスリットパターンを有するレジスト薄膜

層を形成した。このパターンにおける凹凸部の周期は、前記スリット状マスクのラインおよびスペースの間隔、または前記レーザフォログラフィック技術における干渉パターンによって決定される。

【0036】次に、大型真空チャンバー内で、上記スリットパターンを有するレジスト薄膜層を耐エッティングマスクとしてイオンビームエッティング処理を行い、ガラス基板またはそれに相当する基板上を掘削して、各凹凸の断面形状が非対称な三角形である凹凸パターンを形成した。

【0037】次に、上記のような凹凸パターンを有する基板の表面に、熱硬化性エポキシ樹脂を厚さ2000～7000Åで成膜し、加熱ペーリングを施して硬化させ、前記基板上の各凹凸の断面形状が非対称である凹凸パターンに沿って、同様の凹凸パターン、即ち、図2に示す如き断面三角形の凹凸パターンが現れた配向膜を形成した。

【0038】以上のように得られた凹凸パターンを有する一対の基板部を用い、常法に従って液晶を封入し、基板部の表面において凹凸パターンの周期の異なる5種類の液晶表示素子（実施例10～14）を作製した。

【0039】これら実施例10～14の液晶表示素子の夫々において、液晶分子の配向方向、チルトアングル、および配向秩序を測定し、これらと液晶表示素子の基板部表面における凹凸パターンの周期との関係（周期依存）について評価した。結果を下記表1に示す。

実施例15～18

【0040】イオンビーム・エッティング処理の条件を除き、実施例10～14と同様の方法に従って、透明基板上に、各凹凸の断面形状が非対称である三角形状である凹凸パターンを形成して、この形状が基板部表面に現れた液晶表示素子を作製した。詳しくは、イオンビーム・エッティング処理の際に、イオンビーム照射方向と基板法線との角度を、0°を超える有限の角度～76.4°の範囲内で変化させ、液晶と接する基板部の表面において凹凸の傾斜角の異なる4種類の液晶表示素子（実施例15～18）を作製した。

【0041】これら実施例15～18の液晶表示素子の夫々において、液晶分子の配向方向、チルトアングル、および配向秩序を測定し、これらと液晶表示素子の基板部表面における凹凸パターンの傾斜角との関係（傾斜角依存）について評価した。結果を下記表1に併記する。

【0042】

【表1】

周期 依存		実施例	周期 (μm)	傾斜角°	配向方向	チルトアングル	配向秩序	感光性ポリイミド---
1	2	3	4	5	6	7	8	9
5	3.3	1.66	0.833	0.4166	1.7	1.7	1.7	1.7
3	1.66	1.66	1.66	1.66	5.0°	30°	30°	10°
4	0.833	1.66	1.66	1.66	1.7	1.7	1.7	1.7
5	0.4166	1.66	1.66	1.66	0-2°	0-2°	0-2°	0-2°

傾斜角依存

周期 依存		実施例	周期 (μm)	傾斜角°	配向方向	チルトアングル	配向秩序	感光性ポリイミド---
10	11	12	13	14	15	16	17	18
5	3.3	1.66	0.833	0.4166	1.7	1.7	1.7	1.7
3	1.66	1.66	1.66	1.66	4.5°	36°	30°	24°
1	0.833	0.833	0.833	0.833	10°	8°	6°	4°
0	0.4166	0.4166	0.4166	0.4166	0-2°	0-2°	0-2°	0-2°

傾斜角依存

【0043】表1に示す結果より、本発明の液晶表示素子では、凹凸パターンの周期および傾斜角等を変化させることにより、液晶分子の配向方向、チルトアングル等を自在に制御することが可能である。また、何れの場合も液晶分子の配向秩序が良好であり、充分に液晶分子の配向均一性が達成される。この他、本発明の液晶表示素子の光透過特性について、以下の如く評価した。

【0044】まず、実施例1～5と同様の方法に従つて、表面に各凹凸の断面形状が非対称な三角形状である凹凸パターンを有し、凹凸の周期が $0.8 \mu m$ である基板部を形成した。該基板部一組を、凹凸溝の方向が互いに 90° となるよう対向させ、該基板部間に液晶を封入し、本発明の液晶表示素子に相当する液晶セルを形成した。この液晶セルを平行二コル間間に挟み、回転させた場合の光透過率(光源 570nm)を測定した。

【0045】同時に、従来のラビング法によって処理さ

れた基板部を具備する液晶セルを形成した。また、表面に各凹凸の断面形状が対称な三角形状である凹凸パターンを有する基板部を具備した液晶セルを形成した。これらの液晶セルに関する、上記同様に光透過特性について評価した。各液晶セルにおける、セル回転角と光透過率との関係を図4に示す。尚、同図において横軸はセル回転角(deg)、縦軸は光透過率(a.u.)を表す。

【0046】図4の結果より、本発明の液晶表示素子(セル)は、ラビング法により処理された素子と光透過性に関して同等の特性を示すことが示唆され、更にラビング法に比べて素子の欠損、表示画像の欠陥等の発生が低減されることも判る。

【0047】また、基板部の各凹凸の断面形状が対称な四角形である凹凸パターンを有する液晶表示素子では、位相のズレと明暗コントラストが低く、液晶分子に対する配向制御が良好になすことができないことが判る。

11

【0048】

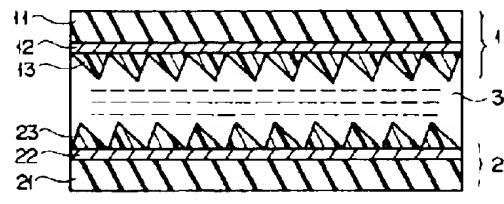
【発明の効果】以上詳述したように、本発明は、基板の汚染、基板上に形成された各素子等の静電破壊等が低減され、液晶画像の欠陥が非常に少なく、且つ液晶分子に対する配向均一性が容易に達成可能な液晶表示素子を提供する上で顕著な効果を奏するものである。

【0049】更に、本発明の液晶表示素子は、製造工程上で製品事故率が大幅に低減され、V-T特性、動画表示状態等の諸特性においても優れた性能を示すことが予想され、その工業的価値は大きい。

【図面の簡単な説明】

【図1】本発明の液晶表示素子における画素部の構造の一例を示す断面図。

【図1】



【図2】本発明の液晶表示素子における配向膜の構造の一例を示す斜視図。

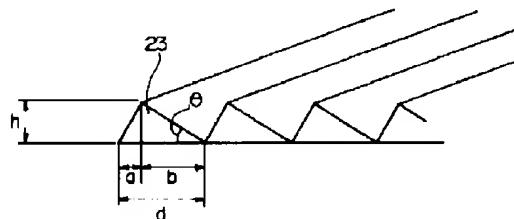
【図3】本発明の液晶表示素子の一実施例における、液晶分子の配向方向と凹凸パターンの周期との関係を示す線図。

【図4】本発明および比較例の液晶表示素子に相当するセルにおける、セル回転角と光透過率との関係を示す線図。

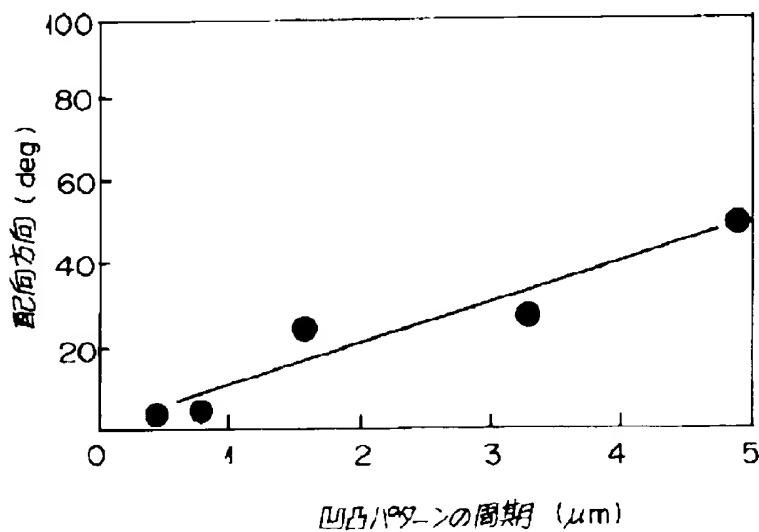
【符号の説明】

1, 2…基板部、3…液晶、11, 21…基板、12, 22…透明導電膜、13, 23…配向膜、a, b…凹凸の傾斜面の水平距離、d…凹凸の一周期、h…凹凸の高さ。

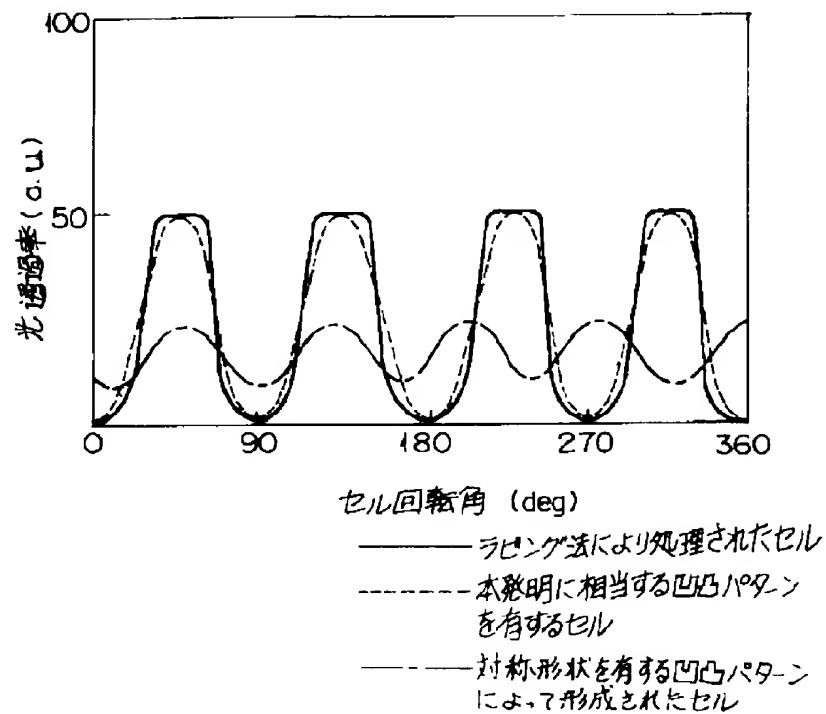
【図2】



【図3】



【図4】



PTO 03-1100 HAMT

Japanese Patent
Document No. 05-088177

LIQUID CRYSTAL DISPLAY ELEMENT
[液晶表示素子]

Kiyoshi Kawada

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C.

12/2002

Translated by: Schreiber Translations, Inc.

Bibliographic Fields

Document Identity

(19) [Publication Office]

Japan Patent Office (JP)

(12) [Kind of Document]

Unexamined Patent Publication (A)

(11) [Publication Number of Unexamined Application]

Japan Unexamined Patent Publication Hei 5 - 88177

(43) [Publication Date of Unexamined Application]

1993 (Heisei 5th year) April 9

(43) [Publication Date of Unexamined Application]

1993 (Heisei 5th year) April 9

(54) [Title of Invention]

LIQUID CRYSTAL DISPLAY ELEMENT

(51) [International Patent Classification, 5th Edition]

G02F 1/1337 7348-2K

[Number of Claims]

1

[Number of Pages in Document]

8

[Request for Examination]

Unrequested

(21) [Application Number]

Japan Patent Application Hei 3 - 251822

(22) [Application Date]

1991 (Heisei 3rd year) September 30

(71) [Applicant]

[Identification Number]

[Name]

TOSHIBA CORPORATION (DB 69-054-3517)

[Address]

72, Horikawa-cho, Saiwai-ku, Kawasaki City, Kanagawa Pref., Japan

(72) [Inventor]

[Name]

Kiyoshi Kawada

[Address]

Toshiba Corporation (DB 69-054-3517) Central Research Laboratory
1, Komukai Toshiba-cho, Saiwai-ku, Kawasaki City, Kanagawa Pref., Japan

(74) [Attorney(s) Representing All Applicants]

[Patent Attorney]

[Name]

Takehiko Suzue

(57) [Abstract]

[Objective]

In liquid crystal display element, the purpose is to decrease the pollution of substrate, the electrostatic breakdown of each element etc which was formed on substrate, and the defects etc of liquid crystal image, and to achieve the orientation uniformity for liquid crystal molecule.

[Structure]

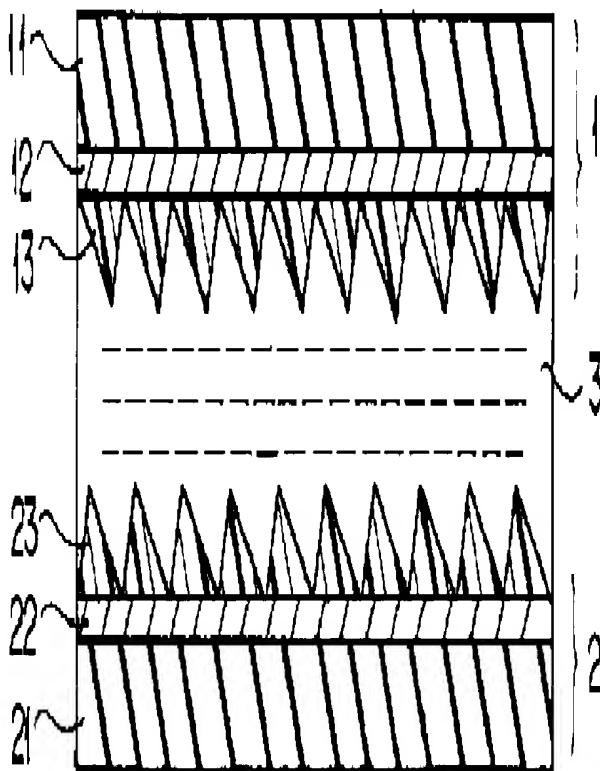
A pair of substrate part 1, 2 which possesses substrate 1 1, 2 1 and orientation film 1 3, 2 3 which covered these are arranged with the interval of fixed distance with orientation film 1 3, 2 3 side as opposite surface

liquid crystal 3 is enclosed between both substrates sections.

In respective substrate part 1, 2, periodic or non-periodic concave and convex shaped patterns are formed on the surface of substrate 1 1, 2 1 and/or the opposite surface of orientation film 1 3, 2 3 where cross section shape of each concave and convex shapes are asymmetrical by chemical treatment.

On the opposite surface which touches the liquid crystal of each substrate part, the cross section shape of each concave and convex shapes which parallels concave and convex shaped pattern of the surface of the aforementioned substrate 1 1, 2 1 and/or the opposite surface of the orientation film 1 3,

2 3 has asymmetrical and periodic or non-periodic concave convex shaped pattern.



[Claim(s)]

[Claim 1]

It is the liquid crystal display element which possesses the orientation film which was formed by polymeric materials which cover the substrate and said substrate surface, a pair of substrate part that is arranged with a constant distance with aforementioned orientation film side as opposite surface and the liquid crystal which is enclosed between the said pair of substrate part.

In respective substrate part , periodic or non-periodic concave and convex shaped patterns are formed on the surface of substrate.and/or the opposite surface of orientation film where cross section shape of each concave and convex shapes are asymmetrical by chemical treatment.

the opposite surface which touches the liquid crystal of each aforementioned substrate part is equipped with periodic or non-periodic concave and convex shaped pattern where the cross section shape of each concave and convex shapes which parallels the concave and convex shaped pattern of the surface of the aforementioned substrate and/or the opposite surface of the orientation film is asymmetrical. The liquid crystal display element has above characteristics.

[Description of the Invention]

[0001]

[Field of Industrial Application]

This invention relates to liquid crystal display element.

[0002]

[Prior Art]

Generally, liquid crystal display element consists of a pair of substrate that are arranged facing each other with constant distance, and the orientation film which covers the surface of respective substrate which mutually opposes, and liquid crystal that is enclosed via these orientation film between the aforementioned substrates.

In this kind of liquid crystal display element, regarding the pixel part the transparent electrode is laminated on aforementioned substrate, furthermore, the orientation film is formed on said transparent electrode, the voltage can be applied by transparent electrode vis-a-vis liquid crystal.

Especially recently, as liquid crystal display element which is used for display system of active matrix type, liquid crystal display element, the driver element such thin film transistor (TFT, Thin Film transistor) etc is mounted on one hand side of substrate in aforementioned pixel part is developed and is utilized.

[0003]

Among constituent component of liquid crystal display element as above-mentioned, regarding the aforementioned orientation film, on the surface which touches the liquid crystal, in order for the liquid crystal molecules 'orientation to be made in a fixed direction, the insulating film surface used to be subjected to the various orientation treatment

As these orientation treatment, treatment which is called rubbing method has been widely executed until recently.

[0004]

Regarding this rubbing method, it is a method whereby it rubs (it does rubbing) in a fixed direction the surface which touches the liquid crystal in insulating polymer film etc which was formed on substrate, making use of cotton and fabric or other fibrous substance, thereby, providing the orientation capability for liquid crystal on film surface

Concerning said orientation capability, shape effective theory and interaction effective theory are proposed wherein according to shape effective theory, due to the fine concave and convex shapes that are formed over the polymer film surface by rubbing, tilt angles of liquid crystal molecules are controlled (the angles of orientation of slanting of liquid crystal molecules toward the substrate), and according to interaction effective theory, the said film surface gets extended while being rubbed, thereby, polymer molecules which form films get oriented, according to this orientation, the directional tendency of orientation and uniformity of liquid crystal molecules are controlled.

In addition, it is thought that by the direction of rubbing treatment, final visual sense direction of liquid crystal display picture is decided.

Regarding the orientation treatment by this rubbing method, since it can use the easy and very simple manufacturing facility by this rubbing method, and it can form the large amount of orientation film quickly and the orientation-regulating force for liquid crystal molecule of treated orientation film is very strong, it is most frequently used for production of present liquid crystal display element

[0005]

But, with above-mentioned rubbing method, regarding the liquid crystal display element with small display surface area (surface area of orientation film is small), it enables the uniform rubbing, on the other hand, regarding the element with large display surface area, it becomes difficult to uniformly set up the contact pressure of fibrous substance against the film surface of substrate (the area of

orientation film is large)

It is not easy to control this contact pressure, furthermore, it originates in durability of fibrous substance which is used, and it changes partially, time wise.

From above, performance of orientation film which is formed becomes non-uniform over the entire membrane, in the mass production, it is difficult to reproduce, and the orientation uniformity of liquid crystal substance in the display images of liquid crystal display element becomes insufficient.

[0006]

In addition, with rubbing method, pollution of substrate and its periphery is caused by constituent ingredient (yarn cutting etc) of fibrous substance which is used.

Furthermore, the process which rubs on dielectric like polymer film by the fabric is included, static electricity of large scale occurs on orientation film.

because of this, substrate surface gets charged statically, rubbish is absorbed and the gap between substrates gets wider than the predetermined spacing , defects are generated in liquid crystal display element which was formed

In addition, at the process wherein the thin film surface on substrate is rubbed with fabric, unnecessary scar occurs in substrate surface, also defect of liquid crystal display picture occurs even by this.

[0007]

Like above, regarding liquid crystal display element which is used for especially aforementioned active matrix type display system, the deficiency of orientation treatment by rubbing method furthermore becomes large problem.

In this kind of liquid crystal display element, since the driver element which is installed on the substrate gets destroyed by the static electricity which occurs by rubbing, the failure rate of this said liquid crystal display element furthermore rises with this.

In addition, in this said liquid crystal display element, on the surface of thin film (orientation film) which covers substrate surface where the driver element(s) in pixel part is (are) mounted, since the concave and convex shapes exists due to the existence of said active element and the flatness is impaired, it is not possible to administer rubbing uniformly over the entire thin film surface.

As a result, the unevenness of treatment occurs at the time of rubbing, the distribution of orientation capability for liquid crystal of orientation film which was formed becomes non-uniform, image loss of liquid crystal display occurs.

In addition, regulation for the rubbing treatment direction is likely to occur, also visual sense direction of liquid crystal display picture is regulated by this, the application range of liquid crystal display element which is formed becomes narrow, and practical value decreases.

[0008]

Like above, with the currently used rubbing method, the large number of problem exists for quality of liquid crystal display element.

Therefore, orientation treatment method (orientation film formation method) which substitutes the aforementioned rubbing method is strongly demanded: several researches are being reported in order to answer this demand.

[0009]

The orientation film formation method presently being researched has been based on the fact below.

Namely, when liquid crystal molecules are put on substrate (orientation film) which possesses linear concave and convex grooves which lines up into equal spacing, it is a fact that these liquid crystal molecule get orientated in a direction which parallels grooves.

Concerning this fact, H.V. it is stated in Physical Review A24 (5)2713 (1981) by H V Kennel et al. and Japanese Journal of Applied Physics 20 (7) in 1343(1981) etc by A. Sugiyama

For instance, in Japan Unexamined Patent Publication Showa 60-60624 number by Yokoyama Kazuo and others, the method is disclosed whereby the grating shaped concave and convex shapes are formed by irradiating 2 light flux interference streak of laser light onto substrate surface.

In addition, in Japan Unexamined Patent Publication Showa 6 1- 11725 number by Tanaka et al, a method is disclosed whereby the orientation film is formed by copying and exposing mask pattern on the negative type photosensitive PVA film.

But, these methods have not reached the industrial practice level yet.

For example, the orientation film of above-mentioned Japan Unexamined Patent Publication Showa 6 1- 11725 number has not had the satisfactory heat resistance in order to be used for liquid crystal display element.

[0010]

In addition, regarding the liquid crystal display element which possesses orientation film as described above, orientation uniformity of liquid crystal molecule is not achieved satisfactorily.

This is presumed that it has originated in the fact that the cross section shape of each concave and convex shape of aforementioned orientation film are symmetrical shape such as rectangular shape.

Namely, when cross section shape of each concave and convex shapes are symmetrical shape, it is considered that it is caused by the fact that it is difficult to optionally control the orientation angles of liquid crystal molecules against the group direction which forms especially concave and convex shapes.

[0011]

[Problems to be Solved by the Invention]

This invention was done considering the above-mentioned problems, the topic is to provide liquid crystal molecule with high performance wherein the pollution of substrate and the electrostatic breakdown of each element etc which was formed on substrate are decreased, and the defects etc of liquid crystal image are decreased, and the orientation uniformity for liquid crystal molecule is achieved.

[0012]

[Means to Solve the Problems]

The liquid crystal display element of this invention has the characteristics wherein it possesses the orientation film which was formed by polymeric materials which cover the substrate and said substrate surface, and is equipped with a pair of substrate part that is arranged with a constant

distance with aforementioned orientation film side as opposite surface and the liquid crystal which is enclosed between the said pair of substrate part; in respective aforementioned substrate part, periodic or non-periodic concave and convex shaped patterns where each concave and convex shaped cross section shape are asymmetrical are formed by the chemical treatment on the surface of the aforementioned substrate and/or the opposite surface of orientation film; and the opposite surface which touches the liquid crystal of each aforementioned substrate part is equipped with periodic or non-periodic concave and convex shaped pattern where the cross section shape of each concave and convex shapes which parallels the concave and convex shaped pattern of the surface of the aforementioned substrate and/or the opposite surface of the orientation film is asymmetrical.

Below, details of this invention are explained.

[0013]

In liquid crystal display element of this invention, the shape of opposite surface which touches liquid crystal of aforementioned substrate part is concave and convex shaped where each convex and concave shaped cross section is asymmetrical, and it is presumed that this concave and convex shapes controls the orientation of liquid crystal molecules.

Generally, the opposite surface which touches liquid crystal of the substrate part corresponds to the surface that touches the liquid crystal of orientation film, hence, concave and convex shape of surface which touches liquid crystal in this orientation film controls orientation of the liquid crystal molecule directly.

[0014]

In this invention, regarding the statement that the cross section shape of each concave and convex shapes on opposite surface of substrate part is asymmetrical, it means that on the cross section which parallels the perpendicular direction vis-a-vis the direction of ridge line (convex part) or valley line (concave part) in said concave and convex shapes, concave and convex shapes are asymmetric graphically.

[0015]

In liquid crystal display element of this invention, it is fine if the concave and convex shaped pattern on the opposite surface of above-mentioned each substrate part is based on at least one layer of shape among the substrate or orientation film which forms substrate part..

Namely, among the substrate and orientation film, it is fine if the surface of at least one layer is equipped with the periodic or non-periodic concave and convex shaped pattern where cross section shape of each concave and convex shapes which was formed by chemical treatment is asymmetrical and this kind of concave and convex shaped pattern appears on the opposite surface which touches the liquid crystal in the aforementioned substrate part at the end.

[0016]

The substrate which forms aforementioned substrate part is usually formed by the raw materials such as the glass etc, furthermore, it is fine if it has the thin layer surface such as copper.

By excavating on this surface by ion beam etching or other chemical treatment, periodic or non-periodic concave and convex shaped pattern can be granted. where cross section shape of each concave and convex shapes are asymmetrical.

[0017]

On one hand, on the orientation film which forms aforementioned substrate part, thin film which was

formed with photosensitive (photocurable) polyimide or other photosensitive polymer is used, by administering photolithography or other chemical treatment to this surface, periodic or non-periodic concave and convex shaped pattern where cross section shape of each concave and convex shapes are asymmetrical can be granted.

In addition, as described above, in case that the substrate surface is treated and possesses concave and convex shaped pattern, photocurable polyimide, thermosetting polyimide, epoxy resin etc can be used as orientation film which covers said substrate.

These resins are formed into a film(s) on the substrate which possesses the concave and convex shaped pattern, furthermore by hardening, the concave and convex shaped pattern are copied on said substrate.

[0018]

This way, in liquid crystal display element of this invention, in cases of both substrate and orientation film, without using treatment by conventional rubbing method, periodic or non-periodic concave and convex shaped patterns where the cross section shape of each concave and convex shapes are asymmetrical are formed.

[0019]

Next, the embodiment of cross section structure in pixel part of liquid crystal display element of this invention, as described above, will be explained, referring to Figure 1 and Figure 2.

Furthermore, as for liquid crystal display element which is shown in Figure 1, the orientation film surface in aforementioned substrate part has the periodic or non-periodic concave and convex shaped patterns where the cross section shape of each concave and convex shapes are asymmetrical, and this concave and convex pattern appears on the surface which touches liquid crystal in the substrate part.

[0020]

In Figure 1, 1 and 2 are substrate part.

substrate part 1 is the laminate of substrate 11 and ITO (indium tin oxide) film or other transparent conductive film 12 (transparent electrode) with the orientation film 13.

In addition, also substrate part 2 has the similar structure, is the laminate of substrate 21 and transparent conductive film 22 and orientation film 23.

said substrate section 1 and 2 is opposed, placing fixed spacing with each orientation film 13, and 23 side as the opposite surface, liquid crystal 3 is enclosed in this opposite surface.

[0021]

In substrate part 1 and 2, on the respective surface of orientation film 13, 23, periodic concave and convex shaped patterns where the cross section shape of each concave and convex shapes are asymmetrical are formed as shown in the figure, and this concave and convex pattern appears on the surface which touches liquid crystal in the substrate part.

Furthermore this said concave and convex shaped pattern can be non-periodic.

[0022]

As for Figure 2, it is an oblique view which shows structure of orientation film 23 in Figure 1 in

detail.

As shown in the same Figure, the cross section shape of each concave and convex shapes of the orientation film 23 has the graphic shape of asymmetric triangle, these concave and convex shapes are arranged linearly.

In liquid crystal display element of this invention, regarding the cross section shape which is formed on this orientation film surface or substrate surface etc, it is desirable that in the asymmetrical concave and convex shapes (concave and convex shapes of substrate part surface) polygonal shape possesses multiple corners in convex part, in order to regulate direction of orientation of liquid crystal molecule

However, the corner in this convex part becomes 1~2 points considering the actual fabrication technology, furthermore, the corner which exists in equal position in each concave and convex shape exists principally in one straight line.

Especially, like an orientation film 23 which is shown in Figure 2, the corner in convex part is 1 point, namely it is desirable that the cross section shape of concave and convex shapes are asymmetric triangle, as to its shape, it is especially desirable that the below-mentioned Formula (1) - (4) is met.

$a < b$... (1)
$a + b = d$... (2)
$d < 1 . 6 7 \times 1 0 -6$... (3)
$h/d > \tan 13$	Deg	... (4)

1 cycle, h shows respectively heights of concave and convex shapes.

Refer to Figure 2)

[0023]

Furthermore regarding the liquid crystal display element where cross section shape of concave and convex shapes in the opposite surface of substrate part is asymmetric triangle, when above Formula (1) - (4) is not met, there is a possibility that the orientation uniformity of the liquid crystal molecule, namely, the degree of orientation order decreases.

But, in this invention, by considering the interaction of orientation film and liquid crystal material, even the liquid crystal display element which does not meet the aforementioned Formula (1) - (4) can sufficiently have improved degree of orientation order of the liquid crystal molecule.

[0024]

liquid crystal display element of this invention can be applied to any of the methods such as simple matrix type, active matrix type that are general liquid crystal display system and it does not hinge on type of liquid crystal molecule or the molecular weight which is enclosed.

[0025]

[Working Principle]

In the liquid crystal display element of this invention, the orientation state control of liquid crystal

molecule is done by the concave and convex pattern in opposite surface of aforementioned substrate part.

This concave and convex shaped pattern is formed by chemical treatment of orientation film which covers substrate or said substrate which forms said substrate section.

Namely, in liquid crystal display element of this invention, the orientation capability for liquid crystal molecule is granted without using conventional rubbing method, the problem such as substrate or other pollution, and electrical destruction of element is evaded, variation-free uniform orientation treatment is done over entire surface of liquid crystal display picture of substrate part.

[0026]

In addition, in liquid crystal display element of this invention, Regarding the concave and convex shaped pattern in opposite surface of the aforementioned substrate, originating in the fact that cross section shape of each concave and convex shapes is asymmetrical, especially, in the vicinity of opposite surface which touches liquid crystal of substrate part, favorably controlling the direction of orientation of liquid crystal molecule is enabled.

Furthermore, by controlling this concave and convex shape, for instance, by controlling one cycle ($d=a+b$), height of convex part (h), asymmetry (a:b), inclination () etc of concave and convex shapes in orientation film which is shown in Figure 2, the orientation direction of liquid crystal molecule, namely, the liquid crystal molecular major axis direction angle for ridge line (convex part) or the trough line (concave part) in the concave and convex grooves of substrate part surface, and tilt angle, namely, the tilt angle of liquid crystal molecule for substrate part surface, can be respectively controlled unrestrictedly.

In this way, orientation uniformity of liquid crystal molecule in liquid crystal display element can be achieved.

[0027]

[Embodied example(s)]

Below, Embodied example of this invention is explained.

Furthermore these embodied example is stated with the objective to make understanding of this invention easy, and this invention is not limited to this.

Embodied example 1~5

[0028]

On each surface of transparent substrate, photosensitive polyimide film is formed with the thickness 700~2000A (angstrom), thus, orientation film layer was formed.

Next, said orientation film layer surface, through mask for exposure which possesses the slit of periodic pattern, was exposed making use of parallel exposure apparatus (PLA-105, Nikon Corporation (DB 69-055-0868) supplied).

This time, in the mask for exposure, spacing of line and the space was set within the range of 1.67 - 0.9 μ m.

Next, developing images, and rinsing processing is done, and it removed unnecessary polyimide, furthermore, annealing is administered at the temperature 230 deg C and the concave and convex

shaped pattern of the periodic cross section of rectangular shape is formed on substrate.

The cycle of concave and convex part in this pattern is decided with the interval of line and space of the mask for aforementioned exposure.

[0029]

Next, inside the large type vacuum chamber, ion beam etching treatment was done vis-a-vis orientation film layer which possesses concave and convex shaped pattern of above-mentioned cross section of rectangular shape, corner of concave and convex shapes of rectangular shape was dropped out, concave and convex shaped pattern is formed where cross section shape of each concave and convex shapes are asymmetric triangle.

Namely, the orientation film which possesses concave and convex shaped pattern of triangle cross section as shown in figure 2 on transparent substrate was formed.

[0030]

Making use of a pair of substrate part which possesses concave and convex shaped pattern which is acquired as above, enclosing the liquid crystal using the customary method, 5 kinds of liquid crystal display element (Embodied example 1~5) were produced where the cycle(s) of concave and convex shaped pattern differs on the surface(s) of substrate part.

[0031]

In respective liquid crystal display element of these Embodied example 1~5, the orientation direction, tilt angle, and orientation order of liquid crystal molecules were measured, and the relationship (cycle dependence) of these and the cycle of concave and convex shaped pattern on the substrate part surface of liquid crystal display element was appraised.

The result is shown in below-mentioned Table 1.

Furthermore, the inclination of each Embodied example in Table 1 corresponds to the angle in concave and convex shapes which is shown in Figure 2.

[0032]

In addition, the plot of Figure 3 shows concerning the relationship between the orientation direction of liquid crystal molecule and the cycle of the concave and convex shaped pattern.

In the same figure, the vertical axis shows the orientation direction of liquid crystal molecule, namely, the angle of liquid crystal molecular major axis direction for valley line (concave) or ridge line (convex part) in the concave and convex grooves of substrate part surface, the horizontal axis shows the cycle of concave and convex shaped pattern respectively.

Embodied example 6~9

[0033]

Excluding the condition of ion beam * etching treatment, following the method which is similar to Embodied example 1~5, on transparent substrate, as shown in the Figure 2, the orientation film which possesses concave and convex shaped pattern where cross section shape of each concave and convex shapes are asymmetric triangle was formed, furthermore, making use of this, liquid crystal display element was produced.

As to the details, at the time of ion beam * etching treatment, The angle of ion beam illumination direction and the substrate normal line is changed within the range of the finite angle~76.4 deg which exceeds 0 deg, 4 types of liquid crystal display element (Embodied example 6~9) were produced where tilt angle of the concave and convex shapes differs on the surface of substrate part which touches liquid crystal.

[0034]

In respective liquid crystal display element of these Embodied example 6~9, the orientation direction, tilt angle, and orientation order of liquid crystal molecule were measured and the relationship (inclination dependence) with these and the inclination of concave and convex shaped pattern on the substrate part surface of liquid crystal display element were appraised.

Result is inscribed to below-mentioned Table 1.

Embodied example 10~14

[0035]

On the glass substrate or on substrate which corresponds to that, thin photoresist film was formed with thickness 1 μm.

Next, through slit shaped mask vis-a-vis said thin photoresist thin film, making use of laser holographic technology, exposure is done.

Here, as the slit shaped mask, the mask which is similar to the mask for exposure which is used with embodied example 1~5 was used.

In addition, as to the laser holographic technology, the exposure for thin photoresist film is done, making use of the interference pattern which is acquired by projection of laser light where phase is controlled, (production technology, Japan Patent No. 1046763 number of Eshelet diffraction grating), it is applied for the orientation film which needs finer microscopic pattern or the materials where exposure is difficult to administer by mask for the aforementioned exposure.

Consequently, one developed images vis-a-vis thin photoresist film after exposing, and rinsed, it formed resist thin film layer which possesses (a) periodic slit pattern on substrate.

As for the cycle of concave and convex part in this pattern, it is decided by the spacing of line and spaces of aforementioned slit shaped mask or the interference pattern of the aforementioned laser holographic technology

[0036]

Next, inside the large type vacuum chamber, the ion beam etching treatment is done with resist thin film layer which possesses above-mentioned slit pattern as resistant etching mask, over the glass substrate or the substrate which corresponds to that is excavated, the concave and convex shaped pattern was formed where cross section shape of each concave and convex shapes are asymmetric triangle

[0037]

Next, on the surface of substrate which possesses concave and convex shaped pattern as described above, the film is formed with thermosetting epoxy resin with thickness 2000~7000A; by administering heating baking it is hardened; alongside the concave and convex shaped pattern where

cross section shape of each concave and convex shapes on aforementioned substrate is asymmetrical, similar concave and convex shaped pattern, namely, the orientation film where concave and convex shaped pattern of triangle cross section which is shown in Figure 2 appears is formed.

[0038]

Making use of a pair of substrate part which possesses concave and convex shaped pattern which is acquired as described above, and following the conventional method, liquid crystal is enclosed and 5 kinds of liquid crystal display element (Embodied example 10~14) are produced where cycle of concave and convex shaped pattern differs on the surface of substrate part..

[0039]

In respective liquid crystal display element of these Embodied example 6~9, the orientation direction, tilt angle, and orientation order of liquid crystal molecule are measured and the relationship (cycle dependence) with these and the cycle of concave and convex shaped pattern on the substrate part surface of liquid crystal display element are appraised.

Result is shown in below-mentioned Table 1.

Embodied example 15~18

[0040]

Excluding the condition of ion beam * etching treatment, following the method which is similar to Embodied example 1~5, on transparent substrate, as shown in the Figure 2, the orientation film which possesses concave and convex shaped pattern where cross section shape of each concave and convex shapes are asymmetric triangle was formed, liquid crystal display element where this form appears on the substrate part surface was produced.

As to the details, at the time of ion beam * etching treatment, the angle of ion beam illumination direction and the substrate normal line is changed within the range of the finite angle~76.4 deg which exceeds 0 deg, and 4 types of liquid crystal display element (Embodied example 15~18) were produced where inclination of the concave and convex shapes differs on the surface of substrate part which touches liquid crystal.

[0041]

In respective liquid crystal display element of these Embodied example 15~18, the orientation direction, tilt angle, and orientation order of liquid crystal molecule are measured and the relationship (inclination dependence) with these and the inclination of concave and convex shaped pattern on the substrate part surface of liquid crystal display element are appraised.

Result is described in below-mentioned Table 1.

[0042]
[Table 1]

周期依存					
実施例	周期(μm)	傾斜角°	配向方向	チルトアル	配向秩序
1	5	17.5	50°	15°	0.9
2	3.33	17.5	30°	10°	0.9
3	1.66	17.5	30°	10°	1.0
4	0.833	17.5	2-4°	0-2°	1.0
5	0.4166	17.5	0-2°	0-2°	1.0
傾斜角依存					
実施例	周期(μm)	傾斜角°	配向方向	チルトアル	配向秩序
6	0.4166	17.5	0-2°	0-2°	1.0
7	0.4166	30	0°	0-1°	1.0
8	0.833	17.5	2-4°	0-2°	1.0
9	0.833	30	0°	0-1°	1.0

周期依存					
実施例	周期(μm)	傾斜角°	配向方向	チルトアル	配向秩序
10	5	17.5	45°	10°	0.9
11	3.33	17.5	36°	8°	0.9
12	1.66	17.5	30°	6°	1.0
13	0.833	17.5	2-4°	0-2°	1.0
14	0.4166	17.5	0-2°	0-2°	1.0
傾斜角依存					
実施例	周期(μm)	傾斜角°	配向方向	チルトアル	配向秩序
15	0.4166	17.5	0-2°	0-2°	1.0
16	0.4166	30	0°	0-1°	1.0
17	0.833	17.5	2-4°	0-2°	1.0
18	0.833	30	0°	0-1°	1.0

[Table 1: Translation]

Periodic dependency						Photo sensitive polyimid Propymid 400 Liquid crystal material ..5CB
Embodied example	Period (μm)	Inclination (deg)	Orientation direction	Tilt angle	Orientation order	
1	5	17.5	50deg	15 deg	0.9	
2	3.33	17.5	30 deg	10 deg	0.9	
3	1.66	17.5	30 deg	10 deg	1.0	
4	0.833	17.5	2 - 4 deg	0 - 2 deg	1.0	
5	0.4166	17.5	0 - 2 deg	0 - 2 deg	1.0	
Inclination dependency						Photo sensitive polyimid Propymid 400 Liquid crystal material ..5CB
Embodied example	Period (μm)	Inclination (deg)	Orientation direction	Tilt angle	Orientation order	
6	0.4166	17.5 deg	0 - 2 deg	0 - 2 deg	1.0	
7	0.4166	30 deg	0 deg	0 - 1 deg	1.0	
8	0.833	17.5 deg	2 - 4 deg	0 - 2 deg	1.0	
9	0.833	30 deg	0 deg	0 - 1 deg	1.0	
Periodic dependency						Thermocurable epoxy Liquid crystal material ..5CB
Embodied example	Period (μm)	Inclination (deg)	Orientation direction	Tilt angle	Orientation order	
10	5	17.5	45 deg	10 deg	0.9	
11	3.33	17.5	36 deg	8 deg	0.9	
12	1.66	17.5	30 deg	6 deg	1.0	
13	0.833	17.5	2 - 4deg	0 - 2 deg	1.0	
14	0.4166	17.5	0 - 2 deg	0 - 2 deg	1.0	
Inclination dependency						Thermocurable epoxy Liquid crystal material ..5CB
Embodied example	Period (μm)	Inclination (deg)	Orientation direction	Tilt angle	Orientation order	
15	0.4166	17.5 deg	0 - 2 deg	0 - 2 deg	1.0	
16	0.4166	30 deg	0 deg	0 - 1 deg	1.0	
17	0.833	17.5 deg	2 - 4 deg	0 - 2 deg	1.0	

18	0.833	30 deg	0 deg	0 - 1 deg	1.0	

[0043]

From the result which is shown in Table 1, in liquid crystal display element of the this invention, by changing the cycle and inclination etc of concave and convex shaped pattern, the orientation direction, tilt angle etc of liquid crystal molecule can be controlled unrestrictedly.

In addition, in all of the cases, the orientation order of liquid crystal molecule is satisfactory, orientation uniformity of liquid crystal molecule is achieved satisfactorily.

In addition, concerning light transmission property of liquid crystal display element of this invention, it was evaluated as below.

[0044]

First, according to the method which is similar to Embodied example 1~5, it possessed concave and convex shaped pattern where cross section shape of each concave and convex shapes are asymmetric triangle on the surface, it formed substrate part where the cycle of concave and convex shapes are $0.8\mu\text{m}$.

a set of said substrate section opposes each other so that the direction of concave and convex grooves become 90 deg mutually, liquid crystal is enclosed between said substrate sail section, it formed liquid crystal cell which corresponds to liquid crystal display element of this invention.

This liquid crystal cell is sandwiched between parallel nicols, it measured optical transmittance rate (light source 570 nm) when it rotated.

[0045]

Simultaneously, liquid crystal cell which possesses substrate part which was treated with conventional rubbing method was formed.

In addition, liquid crystal cell which is equipped with substrate section which possesses concave and convex shaped pattern where cross section shape of each concave and convex shapes are symmetrical triangle on the surface was formed.

In regard to these liquid crystal cell, same as described above, light transmission property was evaluated

In each liquid crystal cell, relationship between cell rotation angle and optical transmittance is shown in Figure 4.

Furthermore, horizontal axis shows cell rotation angle (deg), and vertical axis shows optical transmittance (a.u.) respectively in the same figure.

[0046]

From the result of Figure 4, it suggests that liquid crystal display element (cell) of this invention shows equal characteristic in regard to optical transparency with the element which were treated by the rubbing method, one can understand that, furthermore, the defect of elements or other occurrence of defect of display image is decreased, in comparison with the rubbing method

[0047]

In addition, regarding the liquid crystal display element which possesses concave and convex shaped pattern where cross section shape of each concave and convex shapes of substrate part is symmetrical graphic shape, and the misalignment of phase and light and dark contrast are low, alignment control for liquid crystal molecule can not be done satisfactorily, one can understands.

[0048]

[Effects of the Invention]

As above detailed, as for this invention, , it provides liquid crystal display element whereby the pollution of substrate and each element or other electrostatic breakdown etc which was formed on substrate are decreased, defect of liquid crystal image is minimal, the orientation uniformity at same time for liquid crystal molecule can be attained easily

[0049]

Furthermore, as for liquid crystal display element of this invention, product accident rate is greatly decreased in the production process; it is expected that regarding V-T characteristic, motion picture display condition or other characteristics performance it will show superior performance; its industrial value is large.

[Brief Explanation of the Drawing(s)]

[Figure 1]

A sectional view which shows one example of structure of pixel part in liquid crystal display element of this invention

[Figure 2]

An oblique view which shows one example of structure of the orientation film in liquid crystal display element of this invention

[Figure 3]

A plot which shows the relationship between orientation direction of liquid crystal molecule and the cycle of the concave and convex shaped pattern in one Embodied example of liquid crystal display element of this invention,

[Figure 4]

a plot which shows the relationship between the cell rotation angle and the optical transmittance in the cell which corresponds to liquid crystal display element of this invention and the comparative Example

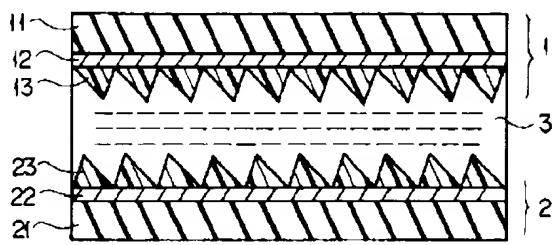
[Explanation of Symbols in Drawings]

1

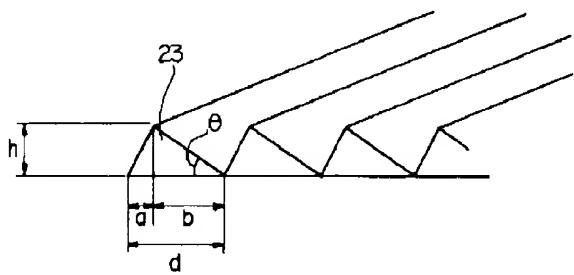
substrate part

11

substrate	12
transparent conductive film	13
orientation film	2
substrate part	21
substrate	22
transparent conductive film	23
orientation film	3
liquid crystal	
a	
horizontal distance of inclined plane of concave and convex shapes	
b	
horizontal distance of inclined plane of concave and convex shapes	
d	
One cycle of concave and convex shapes	
h	
height of concave and convex shapes	
Drawings	
[Figure 1]	

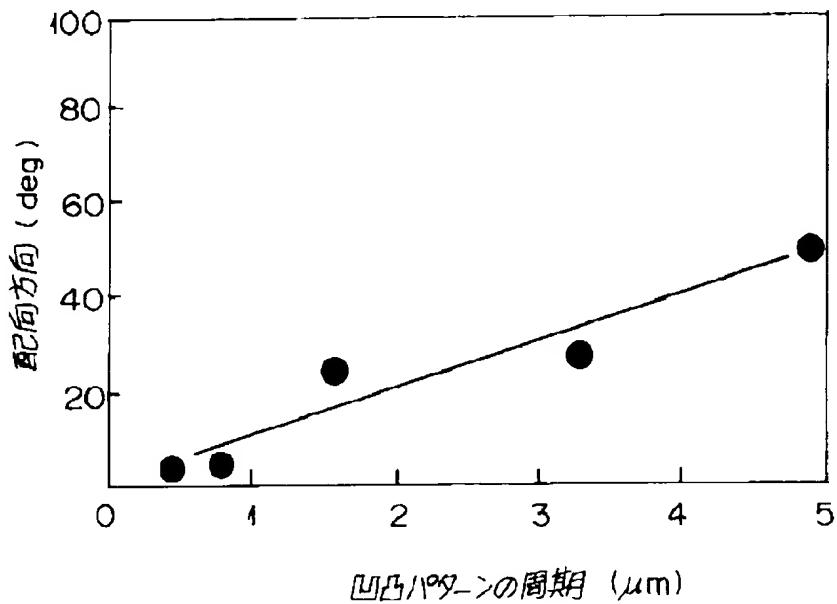


[Figure 2]



[Figure 3]

x axis: orientation direction (deg); y axis: concave & convex pattern period (μm)



[Figure 4]

x axis: light transmittance rate (a.u)

y axis: cell rotation angle (deg)

— cells processed by rubbing method

— - - cells with concave & convex pattern that corresponds to this invention

— - — cells that were formed by concave & convex pattern with symmetrical shapes

